Crustacean Larvae – Academic Script

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Arthropoda
Crustacean Larvae
Introduction:

**Crustaceans, Crustacea, formerly called** Remipedia, form a very large and diversified group of **arthropods**, which includes 52,000 described species. It is not wrong to give this a separate rank of subphylum. It includes known animals as **crabs**, **lobsters**, **crayfish**, **shrimp**, **krill** and **barnacles** ranging in size from 0.1 mm to the Japanese spider crab with a leg span of up to 3.8 m and a mass of 20 kg. Like other **arthropods**, crustaceans have an **exoskeleton**, which they **moult** to grow. They are distinguished from other groups of arthropods, such as **insects**, **myriapods** and **chelicerates**, by the possession of **biramous** limbs, and by the **nauplius** form of the **larvae**.

Crustaceans exhibit a number of larval forms, of which the earliest and most characteristic is the **nauplius**. Several larval forms are met within Crustaceans and specified terms are applied to each one of them.

**Characteristics:**

Mainly crustaceans are free-living **aquatic animals**, but some are **terrestrial**, for example, **woodlice**, also **parasitic**, for example, **Rhizocephala**, **fish lice** and **tongue worms**, and **sessile** for example, **barnacles**, forms are seen. The group has an extensive **fossil record**, dating back to the **Cambrian**, and includes **living fossils** such as **Triops**, which has existed apparently unchanged since the **Triassic** period. More than 10 million tons of crustaceans are produced by fishery or farming for human consumption, the majority of it being **shrimps** and **prawns**.
Krill and copepods are not as widely fished, but form the greatest biomass on the planet. The scientific study of crustaceans is known as carcinology, alternatively, malacostracology, crustaceology or crustalogy, and a scientist who works in carcinology is a carcinologist.

Crustaceans show both direct and indirect development. In most crustacea, development is accompanied by little or more metamorphosis and the various stages of development are known as larvae. This is because the eggs are loaded with very little amount of yolk, microlecithal eggs. Crustaceans may pass through a number of larval and immature stages between hatching from their eggs and reaching their adult form. Each of the stage is separated by a moult, in which the hard exoskeleton is shed off to allow the animal to grow. The larva of crustaceans often bears little resemblance to the adult, and there are still cases where it is not known what larvae will grow into what adults. This is especially true of crustaceans which live as benthic adults on the sea bed, but where the larvae are planktonic and therefore more easily caught. Also all crustaceans show a marked transition in morphology during metamorphosis. Radical change in morphology is linked to the loss or gain of distinctive features that mark a change in mode of life. A change in lifestyle during development has significance in terms of evolutionary pressure, as the crustaceans could pass through several ecological niches on the way to adult development and changes would strongly affect survivorship and dispersal.

Many crustacean larvae were not immediately recognized as larvae when they were discovered, and were described as new genera and species. The names of these genera have become generalized to cover
specific larval stages across wide groups of crustaceans, such as *zoea* and *nauplius*. Other terms described forms which are only found in particular groups, such as the *glaucothoe* of *hermit crabs*, or the *phyllosoma* of *slipper lobsters* and *spiny lobsters*.

**Life cycle**

At its most complete, a crustacean's life cycle begins with an *egg*, which is usually fertilized. This egg hatches into a pre-larva and then through a series of moults, the young animal passes through various stages, followed by post-larva. This is followed by *metamorphosis* into an immature form, which broadly resembles the adult, and after further moults, the adult form is finally reached. Some crustaceans continue to moult as adults, while for others, the development of *gonads* signals the final moult.

**History of the study of crustacean larva**

Antonie van Leeuwenhoek was the first person to observe the difference between larval crustaceans and the adults when he watched the eggs of *Cyclops* hatching in 1699. Despite this, and other observations over the following decades, there was a controversy among scientists about whether or not *metamorphosis* occurred in crustaceans, with conflicting observations presented, based on different species, some of which went through a metamorphosis, and some of which did not. This controversy persisted until the 1840s, and the first descriptions of a complete series of larval forms were not published until the 1870s.

Crustacean larvae can be studied under different heads:-
1. **NAUPLIUS**

1. The simplest, commonest and earliest larval form in crustacea.
2. It is a microscopic, oval or pear shaped with an unsegmented body having a broad anterior head region, an intermediate trunk and a posterior bilobed anal region.
3. It has 3 pairs of unjointed appendages bearing seate for swimming.
4. The first pair is uniramous and becomes the antennules of the adult.
5. Second is antennary and third is mandibular to become the respective parts of the adult.
6. The head region bears a noticeable sessile median eye.
7. The mouths open anteriorly between the bases of antennary and mandibular feet.
8. The anus lies at the extremity of the caudal region.
9. The alimentary canal is straight and made of foregut, midgut and hindgut.
10. However mouth and alimentary canal are lacking in nauplius of Cirripedia.
11. The larva is without a heart and has a segmented ventral nerve cord.

2. **METANAUPLIUS**

1. It is indistinctly defined stage following the nauplius.
2. It consist an oval cephalothorax, an elongated trunk-region and an abdomen terminating in a caudal fork provided with setae.
3. Dorsal shield of the head grows back to form the carapace.
4. In addition to the basic appendages of nauplius, it also develops the rudiments of four pairs of appendages, which become the maxillulæ the maxillæ and first two pairs of maxillipeds of the adult.
5. **Branchiopoda, Cephalocardia** and perhaps some **Stomatopoda** hatch at this stage.

### 3. CYPRIS
1. In some **Cirripedia** like **Lepas**, the nauplius passes into the cypris, meaning mussel stage, in which the body and the appendages are enclosed within bivalved carapace with an adductor muscle to close it.
2. Its modified antennules have **cement glands** situated at their bases.
3. It undergoes a remarkable series of metamorphoses to become the sessile adult form.
4. **Ostracods** eggs typically hatch in the cypris form.

### 4. KENTROGEN LARVAE
1. It is the larva of sacculina an exclusive parasite of crab.
2. It is attached to the body of the host crab.
3. It looks like a sac covered with a cuticle.
4. The bag encloses a mass of germ cells.
5. The larva has a chitinous tube called dart.
6. At a later stage the dart pierces through the body of the crab and the germ cells of the larva pass into the body of the host.
7. Inside the host crab the kentrogen develops into the next larva **sacculina interna**.
8. It ultimately develops rhizoids and matures to adult parasitic sacculina.

5. **PROTOZOA**
   1. The metanauplius larva is succeeded by the protozoaea stage with seven pairs of appendages and the beginning of segmentation.
   2. The carapace become enlarged and covers the dorsal surface anteriorly.
   3. The seven pairs of appendages present in the metanauplius, up to 2\textsuperscript{nd} maxillipede, become well-developed and capable of movements.
   4. The rudiments of paired lateral eye begin to appear near the median eye.
   5. The rudiments of the remaining posterior six thoracic segments are also marked off, but the abdomen still remains unsegmented and limbless.
   6. The protozoaea swims by antennae.
   7. **Penaeus** hatch in the **protozoaea stage**.

6. **ZOEA**
   1. Zoea is the second important larvae of the Crustacea, the first being the nauplius.
2. Protozoaea stage is succeeded by the zoaea stage characterized with a distinct cephalothorax and abdomen, eight pair of appendages and buds of six more, it looks like adult Cyclops.

3. The cephalothorax is highly developed and covered by a helmet-like carapace, which is produced into two long spines, an anterior median rostral and a posterior median dorsal. Sometimes two lateral spines are also present.

4. The paired lateral and stalked compound eyes become well formed.

5. The long abdomen is clearly made of six segments, and terminates in a caudal fork.

6. Abdomen still lacks appendages and hence larvae swim by means of thoracic limbs.

7. **METAZOEA**
   
   1. Metazoea is the older zoea and has well formed third maxillipedes, which are biramous and swimming organs in Anomura, but uniramous and non-swimming in Brachyura.
   
   2. The six pairs of abdominal appendages also appear in the form of buds.

8. **CALYPTOSIS**
   
   1. In *Euphausiacea*, one of the larval stages is termed calyptopsis. It is similar in all respects to a typical zoea except that the paired eyes are not stalked but sessile.
9. ERICHTHUS
1. Such larvae are met with in *Lysiosquilla* and have characteristically a carapace that covers the greater part of the body.
2. Head is unsegmented, bearing median and paired eyes and all the five pairs of cephalic appendages.
3. The thorax is made up of segments, free from the carapace, and bearing anterior five pairs of biramous swimming appendages.
4. The broad abdomen is unsegmented and with a single pair of appendages.

10. ALIMA
1. The so-called alima larva of Squilla which hatch out from the egg directly, is a modified zoea.
2. Being pelagic and having a glass-like transparency it occurs in large numbers in the plankton.
3. It has a slender form, and a sort and broad carapace.
4. All the head appendages are present.
5. Abdomen is six-segmented, having 4 or 5 pairs of pleopods i.e. swimming legs.
6. The alima larva differs from the zoea larva in the armature of the telson and a very large raptorial second maxillipede.

11. MEGALOPA
1. All the true crabs with the zoaea larva or metazoaea passing through successive moults develop into the post larval megalopa stage.
2. It has a broad and a crab like unsegmented cephalothorax.
3. The carapace is produced anteriorly into a median spine.
4. The eyes are large, stalked and compound.
5. All the thoracic appendages are well formed of which the last five pairs uniramous.
6. The abdomen is also well formed, straight and bears biramous pleopods.

12. GLAUCOTHOE
1. In hermit crabs, the metazoea leads to the glaucothoe stage.
2. It corresponds to the megalopa stage of Bracchyura with a large symmetrical abdomen and a full complement of adult appendages.

13. MYSIS
1. In Penaeus, the zoea, instead of converting into the megalopa stage, mouls into the postlarval mysis larva within thirteen pairs of appendages.
2. All thoracic appendages are biramous.
3. Even the five pairs of posterior thoracic legs are biramous with flagellar exopodites which take up the locomotory function(Which is chiefly by the antennae in other larvae.)
4. The abdomen develops similar to that of the adult form, with five pairs of biramous pleopods and a pair of uropods and telson.
5. The mysis larva metamorphoses in to the adult prawn, by losing the exopodites of the thoracic legs.
14. PHYLLOSOMA

1. It is the newly hatched larva of the rock-lobster, *Palinurus*, it is also called glass-crab and is a greatly modified mysis stage.
2. It is a remarkable for its large size, extremely flattened and a leaf-like delicate form and glassy transparency.
3. A narrow constriction demarcates the head from the thorax.
4. A large oval carapace covers the head and the first two thoracic segments.
5. The eyes are largely stalked and compound.
6. Only anterior six pairs of thoracic appendages are present in the newly hatched larva.
7. The first thoracic appendages or maxillipedes are rudimentary in case of *Palinurus* or absent in case of *Scyllarus*.
8. The second are uniramous and succeeded by four pairs of very long biramous legs with notary exopodites.
9. Last two pairs of thoracic appendages are usually absent.
10. Abdomen, though indistinctly segmented is very small and limbless.
11. Phyllosoma undergoes several molts before reaching the adult form.

**SUMMARY**

Crustaceans show both direct and indirect development and may pass through a number of larval and immature stages between hatching from their eggs and reaching their adult form. In most crustacea, development is accompanied by little or more metamorphosis and the various stages of development are known as larvae. They are _nauplius_, _metanauplius_, _cypris_, _kentrogen_, _protozoea_, _zoea_ _, _metazoea_, _calyptosis_, _erichthus_, _alima_, _megalopa_, _glaucothoea_, _mysis_ and _phyllosoma_. Each
of the stages is separated by a **moulting** process, in which the hard **exoskeleton** is shed to allow the animal to grow. Most **larvae** of crustaceans often bear little resemblance to the adult. All crustaceans show a marked transition in morphology during metamorphosis. Drastic change in the morphology is linked to the loss or gain of distinctive features that mark a change in mode of life. This change in lifestyle during development has significance in terms of evolutionary pressure, as the crustaceans could pass through several ecological niches on the way to adult development and changes would strongly affect survivorship and dispersal.